ANALYSIS OF THE SUB-SURFACE OF ALBA PATERA, MARS USING PIT CRATERS. K.K. Zuromski and K.M. Jager, Community College of Rhode Island, Department of Physics, Lincoln, RI, 02865 USA, (kbuzzin@aol.com; kjager@ccri.cc.ri.us).

Introduction: Alba Patera is located on the Tharsis rise at the edge of the northern lowlands. Alba is interpreted to have a history of both plinian-style (explosive) eruptions producing pyroclastic flows and ash deposits, as well as effusive mafic eruptions [1,2,3,4]. These eruptions formed the edifice of the volcano. A layer of atmospheric dust composed of silicates, oxides, and sulfates covers most of the surface on Mars [5]. Therefore, both basalt and less consolidated ash and dust are expected on Alba.

Pit chains, or catenae, are found on the southern and eastern flanks of Alba within some of the grabens. These pits were formed by either the collapse of overlying rock material into a void space created by a gas cavity formed at the top of a stalled dike [6], or by the collapse of a tension fracture opening underground [7,8]. The collapse of these pits creates unaltered cross-sections of the Martian crust, giving a three-dimensional perspective into the uppermost layers of Alba Patera. This will ultimately give us a better understanding of the surface of Mars.

Methods: Mars Orbiter Camera (MOC) images were analyzed to study the surface features and measure layers (Figure 1 and 2). There are 372 MOC images of Alba Patera, and 21 images of pits, with some images containing more than one pit. The seven pit images used in this study were chosen because of their relatively well-defined layers. The sub-surface layers exposed by the pits were analyzed to determine their thickness, whether or not they are continuous within individual pits and between pits, and their probable composition.

The thicknesses of layers were measured on the MOC image. To convert these to the actual thickness of the layers, the slopes of the sides of the pits needed to be determined. The average slopes of the select pits on Alba Patera are 18° and the maximum slopes of the pits are 30° as measured by the Mars Orbiter Laser Altimeter (MOLA) [9]. The slopes are steepest in the upper parts of the pits. Because MOLA profiles have a horizontal footprint of 300-400 m [10] these MOLA slopes include several layers and are therefore an average of several layers. Since the darker layers appear steeper than the surrounding layers (see Discussion), we assume a slope of 45° for the dark layers. The light layers make up most of the pit, so we used the average pit slope (18°), to determine the thickness of the light layers. Because we do not know the exact slopes, a margin of error is introduced in our measurements.

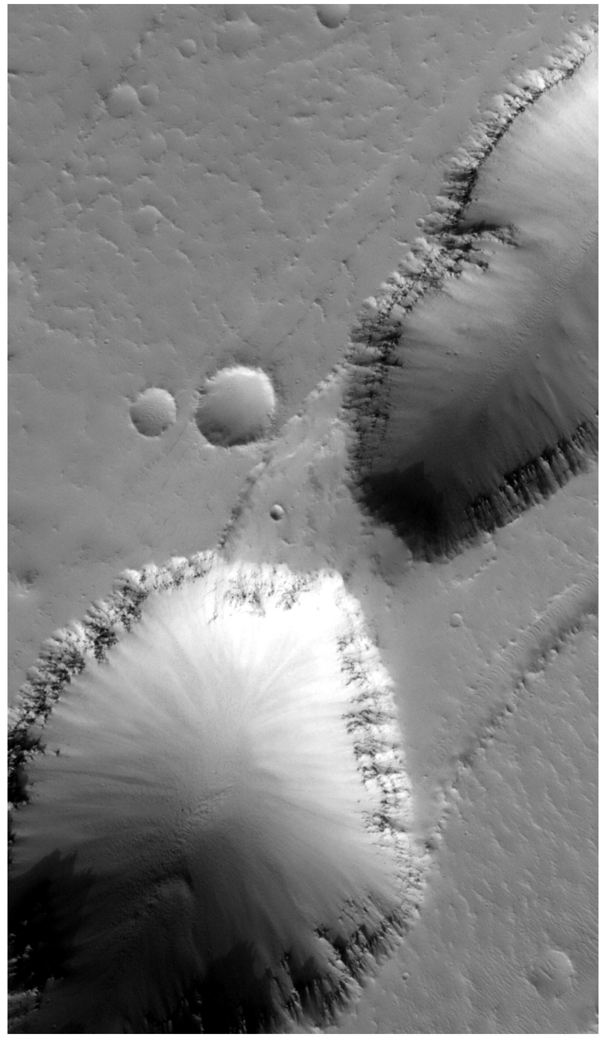

Figure 1: Pits showing light and dark layers. MOC image E10-03054; 4.79 m per pixel; 3.09 km wide (Figure 2 is a close up of top pit).

Results: Analysis of pit chains determined that alternating light and dark-toned layers are present in pits. The light layers are more gently sloping than the steeper dark material. The light material covers most of the surface of the pits and forms sand dunes on the bottoms of some pits. The dark layers appear to be outcrops of bedrock, often making prominences against the surrounding slope, and always form the lower-most layer. The number of dark layers within individual pits ranges between one and four.

For the pits analyzed, the average thickness of the dark layers is 50 m, and the average thickness of the lighter layers is 34 m. Although the lighter layers appear wider on the image, this is due to their gentler slope.

Layers are not always continuous throughout individual pits or between nearby pits. However, the lighter layers are often more consistent within individual pits and nearby pits than the dark layers. For example, in the bottom pit in Figure 1, the two lower light layers vary in width between 16 m and 20 m throughout the pit. The top pit in the same image has a lower light layer width of 26 m on the west side. The uppermost light layers of these pits are also similar, measuring 39-40 m in both pits.

In contrast, the dark lower layer in the bottom pit ranges in thickness from 72 m on its western side to 29 m on its northern side. The top pit in Figure 1 has an uneven number of dark layers in its western side that do not continue across the whole 2.2 km pit (Figure 2). If the dark layers are the same layers between pits, then they differ in thickness by up to 37 m.

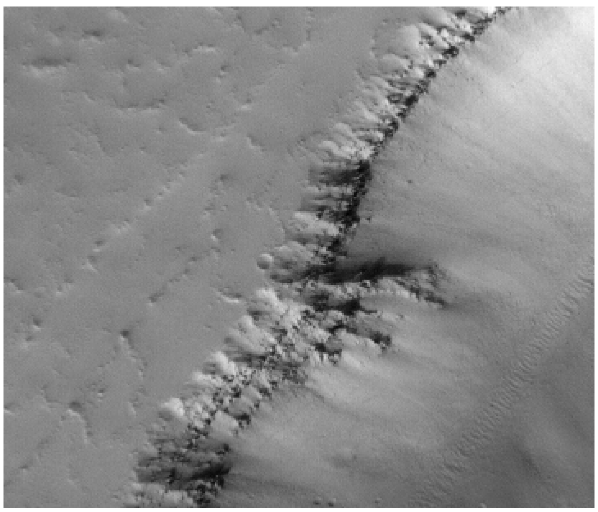

Figure 2: Close up of western edge of top pit in Figure 1. Notice the inconsistent layers and varying thicknesses of individual layers. Image width is 1.73km.

Discussion and Conclusion: We interpret the dark layers to be basalt lava flows erupted from Alba Patera, since lava flows on Alba are interpreted to be basalt [1,2,4]. The lighter units are composed of dust, ash, and pyroclastic materials, which may have erupted from Alba or were deposited on Alba by the Martian wind.

The dark layers are always the bottom layer in the pit and form a cliff. Although the deepest exposed dark layer is 490 m below the surface, we interpret the darker layers to continue below where they are exposed. Below the cliff the dark layers cannot be seen because they are buried by the infill of gently sloping light material.

The thickness of the dark basalt lava flow layers correspond to the thicknesses of lava flows measured on Alba Patera. The measurements of the thicknesses of the dark layers in the analyzed pits range from 8m to 96m thick. Lava flows on Alba Patera have been measured to range from 40 to 150m thick, although these thicknesses are for the thicker, more obvious flows [11,12,13]. The widths of measured lava flows range (depending on the flow type) from 1.5 to 25 km wide [4,12].

The light layers between the dark lava flow layers indicate that Alba Patera did not erupt basalt continuously, which is in agreement with previous studies [2]. Instead, there were breaks, either where pyroclastics were erupted, or where the volcano was quiet and windblown materials settled on the previous flows.

When viewed in a context image, we can see that the pits in Figure 1 are located on a lava flow. However, this lava flow is not obvious in the layers of the MOC image. This discrepancy suggests that lava flows on Mars may not be as simple as they appear in larger-scale images.

From the evidence left by the collapse of pits we are able to examine the subsurface layers and determine their thickness, consistencies, and their apparent formation. The dark and light layers occur in an alternating pattern. We determined that the dark layers within the pits are composed of basalt erupted from the volcano. The thicknesses are consistent with the measured thicknesses of lava flows on Alba. We also determined that the light layers are composed of unconsolidated pyroclastic material, dust, and ash and were deposited during breaks in the eruption of lava.

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